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Construction of concrete paving blocks using industrial wastes

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Abstract

Current research investigation is an attempt of the utilization of industrial wastes like fly ash and plastic waste in concrete for the construction of concrete paving block as partial replacement of cement and coarse aggregate with the water-cement ratio of 0.55 and 0.6. The concrete paving block was constructed with the nominal mix of 1:2:4, partial replacement of cement and coarse aggregates were 15% and 5% with fly ash and plastic waste. The research objectives are to determine the compressive strength, flexure strength, and split tensile strength of the concrete paving block. Specimens were tested for a duration of 7, 14, and 28days. The study shows that the cement can partially be replaced with fly ash, and coarse aggregate can partially be replaced with plastic waste. The biggest advantage of the utilization of fly ash and plastic waste in the concrete paving block can reduce its excessive unused amount. Due to the disposal of these materials in open land, a large area is affected and remains useless, also. Fly ash dust is becoming a problem for an open atmosphere. The utilization of industrial waste materials in concrete can leads towards the reduction of environmental pollution. Result of the experimental program shows that in 0.55 water-cement ratio Mechanical strength of concrete specimens like compressive strength, split tensile strength and flexural strength are almost same after 28 days testing in a laboratory.

Keywords: *Fly ash; Mechanical strength; Plastic waste.*

1. INTRODUCTION

Concrete paver block is a good idea with the advancement of waste materials like fly ash and plastic waste. These materials are hazardous for an atmospheric perspective, and environmental pollution is increasing due to the daily production of these materials. Nowadays, the production of cement cannot be restricted due to the increasing demand and regular construction, neither the production of concrete. Production of cement has resulted in the same amount of emission of CO_2. An approach is to be taken in this research investigation towards the use of industrial wastes like fly ash and plastic waste in concrete for the construction of the paving block. Fly ash and plastic wastes are having no use except to utilize as a building material. Mostly these materials are disposed of on the open ground, resulting in environmental pollution and land problems. These materials are not only the big problems for open land but also the particles of fly ash are mixed with air and causing health issues. Plastic waste and fly ash depositing in surrounded water bodies are becoming big problems for living creatures. For the safety of health, life cycle, and environment, monitoring and maximum utilization of these materials are required.

Pavement blocks are the perfect solution on the pathway and streets for simple laying and finishing. Here the strength properties of pavement blocks comprise the use of waste plastics and fly ash as partial replacement of coarse aggregate and cement in concrete. Owing to this idea, the present research investigation refers to the utilization of waste products, fly ash, and plastic waste in concrete. The aim of this research is to partially replace cement and coarse aggregate with fly ash and plastic waste. Results are compared with the referral concrete specimens to check the compressive, split tensile and flexural strength with the water-cement ratios of 0.55 & 0.60. A nominal mix of 1:2:4 was considered using a methodology based on IS 10262:2009 for specimen construction. Ahirrao *et al.* (2013) investigated that the pavement blocks made by replacing 25% of fly ash against cement, admixture 0.35% by weight of cement shows the best strength among the concrete pavement blocks containing other waste. Tapkire and Patil (2014) observed that the reused plastic as aggregate as a part of paver blocks recycled plastic as aggregate in concrete is satisfactory. Utilization of the 20% recycled plastic aggregate in concrete does not influence the properties of cement. Nivetha *et al.* (2016) Observed that the production of plastic paver blocks from the solid waste (quarry dust, fly ash & PET) is significant. Plastic waste was carried to melt and mixed with a varying proportion of solid waste fly ash, and quarry dust (PET 25-35%, fly ash 25%, and quarry dust 40-45% in weight) gave more strength when comparing with all other proportions and concluded that solid waste could be used as a

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main constitution for the preparation of paver block with the increased strength.

2. MATERIALS & METHODOLOGY

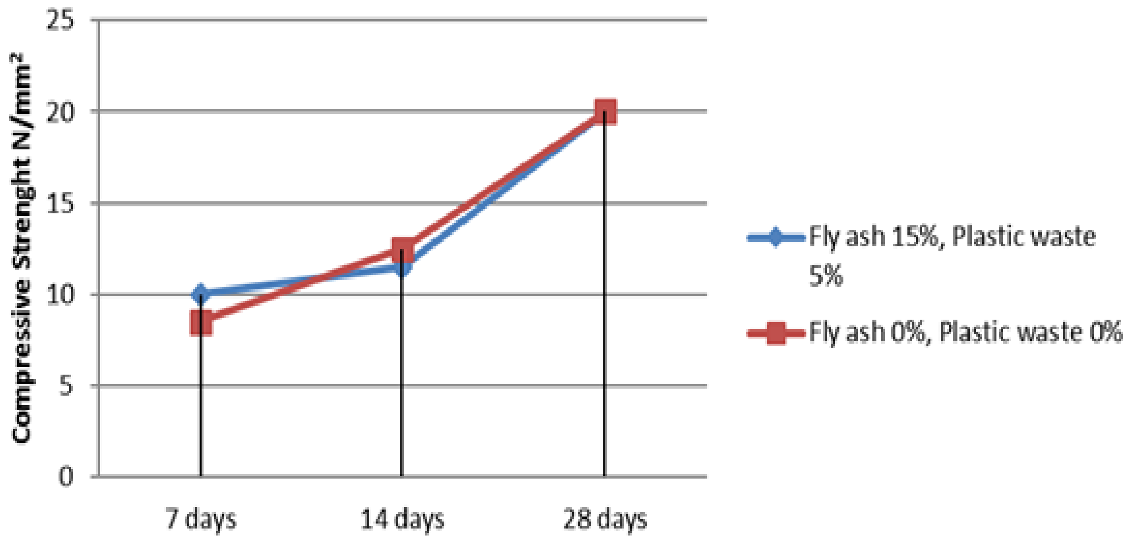
In this experimental research, 15% of cement is partially replaced with fly ash and 5% of crushed plastic waste to aggregate. To examine the results, 36 cubes, 24 cylinders, and 24 beams were prepared in the laboratory with water-cement ratios of 0.55 and 0.60, and the specimens are tested at the end of the 7, 14, and 28 days of curing. For the whole experimental design, PPC cement of prism brand used, locally available river sand was taken in research, fly ash and gypsum were also added in the mix of the specimen. Mixing has done using a nominal mix of 1:2:4, 84 specimens were cast to determine the compressive strength, split tensile and flexural strength at 7, 14, and 28 days, respectively. Test data for the materials are, cement used = PPC (Portland pozzolana cement), specific gravity of cement = 2.6, specific gravity of coarse aggregate = 2.75, specific gravity of fine aggregate =2.66, water absorption of coarse aggregate = 0.5%, water absorption of fine aggregate =1%.

3. RESULTS & DISCUSSIONS

Fly ash and plastic waste are one of the biggest problems in the current age. Since its disposal in open land is harmful, its utilization is also contained on a short scale. This study reveals one of the uses of fly ash as well as plastic waste in addition to concrete in construction. Although fly ash is already available in cement but in fewer amounts, there is again also a possibility of the use of fly ash in concrete. Plastic waste can be used as a replacement of coarse aggregate in a partial amount. For the obtained laboratory results, detailed explanations are discussed below.

Table 1. Compressive strength of cube at water-cement ratio 0.55

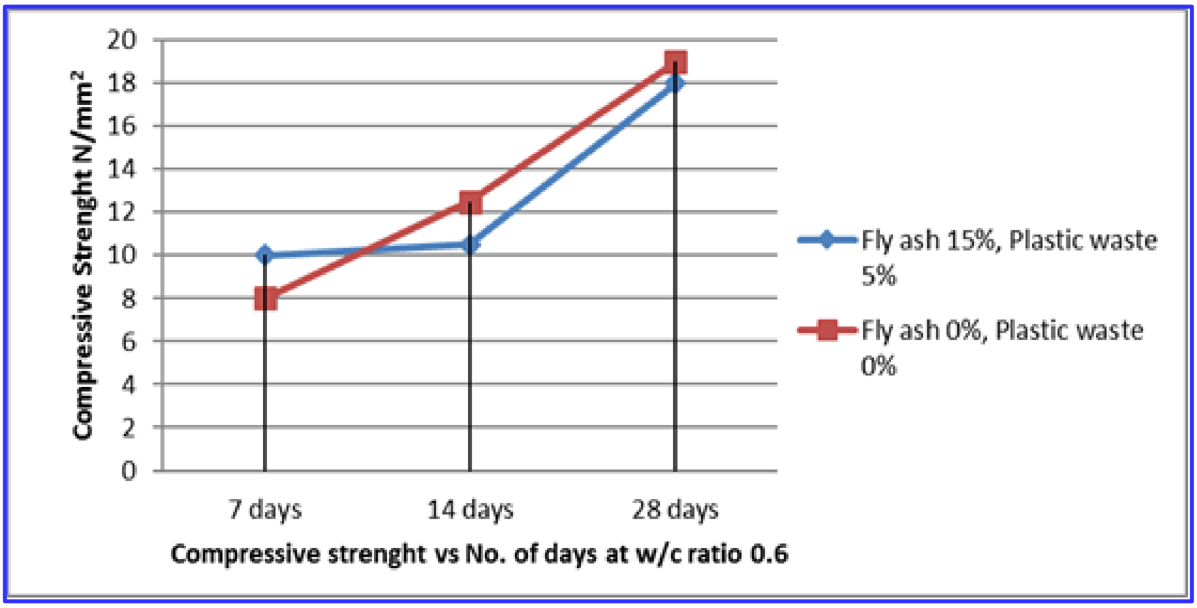
S.N.	Cube designation	Compressive strength (N/mm)^2			% age of fly ash	% age of plastic waste	w/c ratio	Avg. wt. of the cube specimen(N)
		7 days	14 days	28 days				
1	V1	8.5	12.5	20	0	0	0.55	24
2	V2	10	11.5	20	15	5	0.55	23.5



Compressive Strenght vs No. of days at w/c ratio 0.55

Table 2. Compressive strength of concrete at w/c ratio 0.6

S.N.	Cube designation	Compressive strength (N/mm)^2			% age of fly ash	% age of plastic waste	w/c ratio	Avg. wt. of the cube specimen(N)
		7 days	14 days	28 days				
1	V1	8.0	12.5	19.0	0	0	0.6	2.4
2	V2	10	10.5	18.0	15	5	0.6	2.4



Compressive strength results were obtained for referral mix and addition of fly ash and plastic waste. Variation in strength is reported from 20MPa to 20MPa at 28days for a water-cement ratio of 0.55 and 19MPa to 18MPa at 28 days for a water-cement ratio of 0.6. Test results indicate that compressive strength was the same after the addition of fly ash and plastic waste in the water-cement ratio of 0.55. But in 0.6 water-cement ratio, compressive strength is decreasing.

Table 3. Split Tensile strength of concrete at water-cement ratio 0.55

S. N.	Cylinder designation	Split tensile strength(N/mm^2)			% age of Fly ash	% age of Plastic Waste	W/C Ratio	Avg. Wt. of the Cylinder specimen (N)
		7 days	14 days	28 days				
1	C1	4.5	8.0	10.0	0	0	0.55	6.35
2	C2		5	10.0	15	05	0.55	6.5

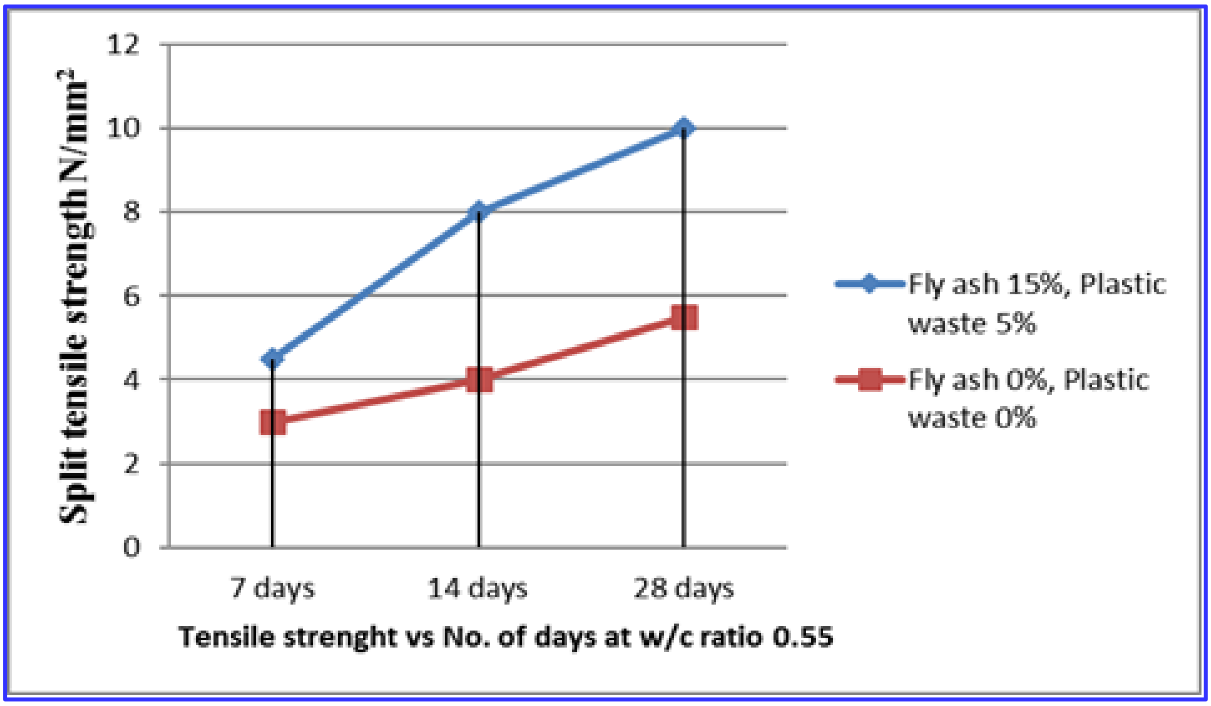
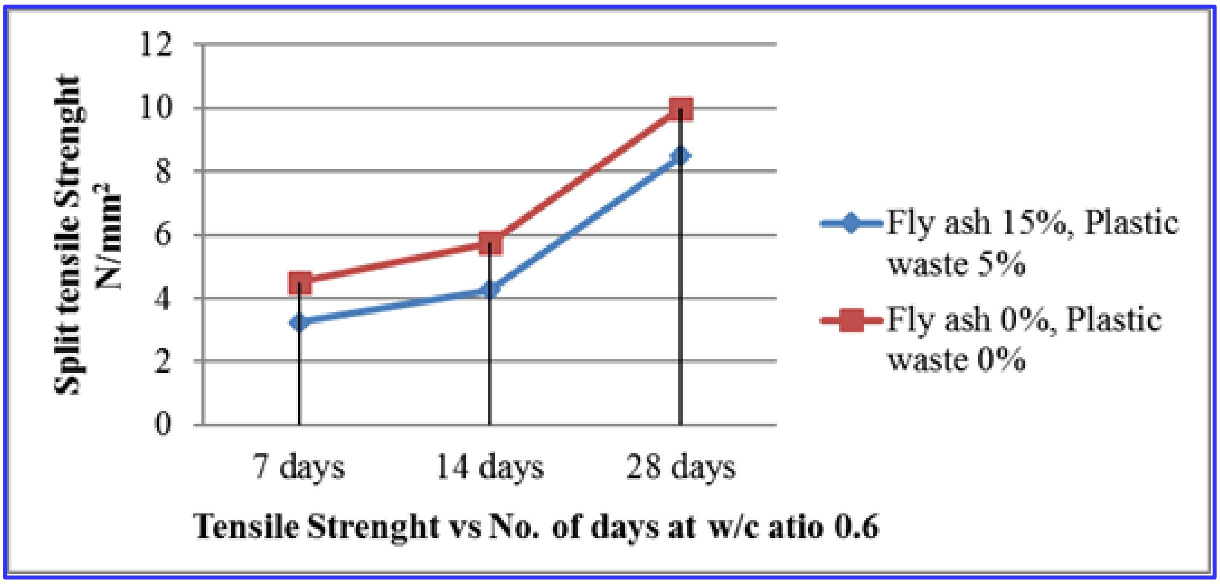


Table 4. Split Tensile strength of concrete at water-cement ratio 0.6

S.N.	Cylinder designation	Split tensile strength (N/mm^2)			% age of fly ash	% age of plastic waste	W/C ratio	Avg. Wt. of the Cylinder specimen (KN)
		7 days	14 days	28 days				
1.	C1	4.5	5.75	10.0	0	0	0.6	6.65
2.	C2	3.25	4.25	8.5	15	5	0.6	6.7



Splitting tensile strength of concrete varies from 10.0MPa to 10.0MPa 28 days for the water-cement ratio of 0.55 and 10.0MPa to 8.5MPa at 28 days for the water-cement ratio of 0.6. Similar behavior was found in split tensile testing like compressive strength, incorporation of fly ash, plastic waste. Overall, experimental results show that industrial wastes like fly ash and plastic waste can be utilized as replacement or addition in concrete.

Table 5. Flexural strength of concrete at water-cement ratio 0.55

S.N.	Beam designation	Flexural strength(N/mm^2)			% age of Fly ash	% age of Plastic Waste	W/C Ratio
		7 days	14 days	28 days			
1	B1	6	7	7.75	0	0	0.55
2	B2	6	6	7.0	15	05	0.55

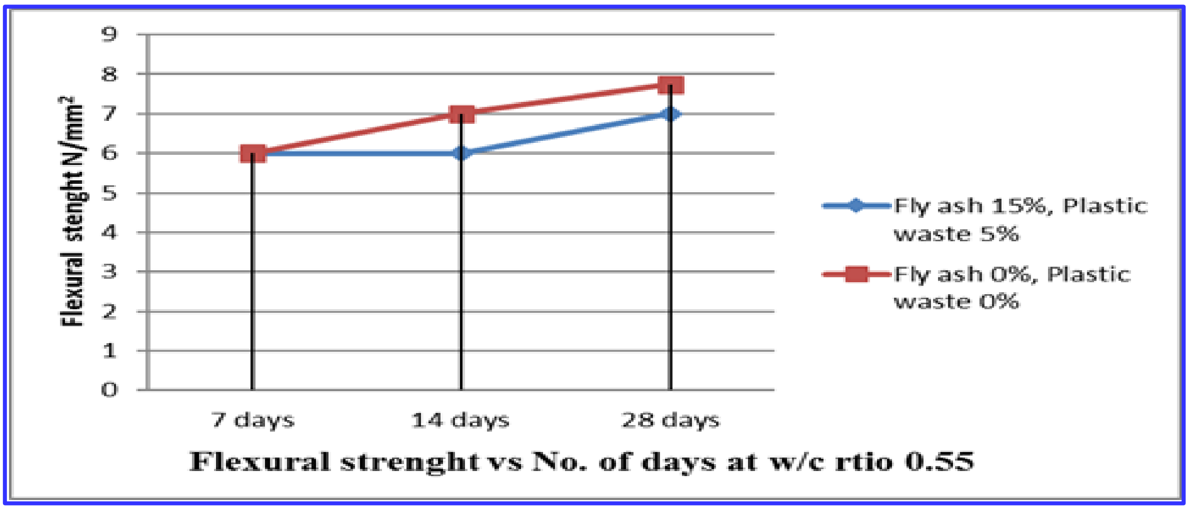
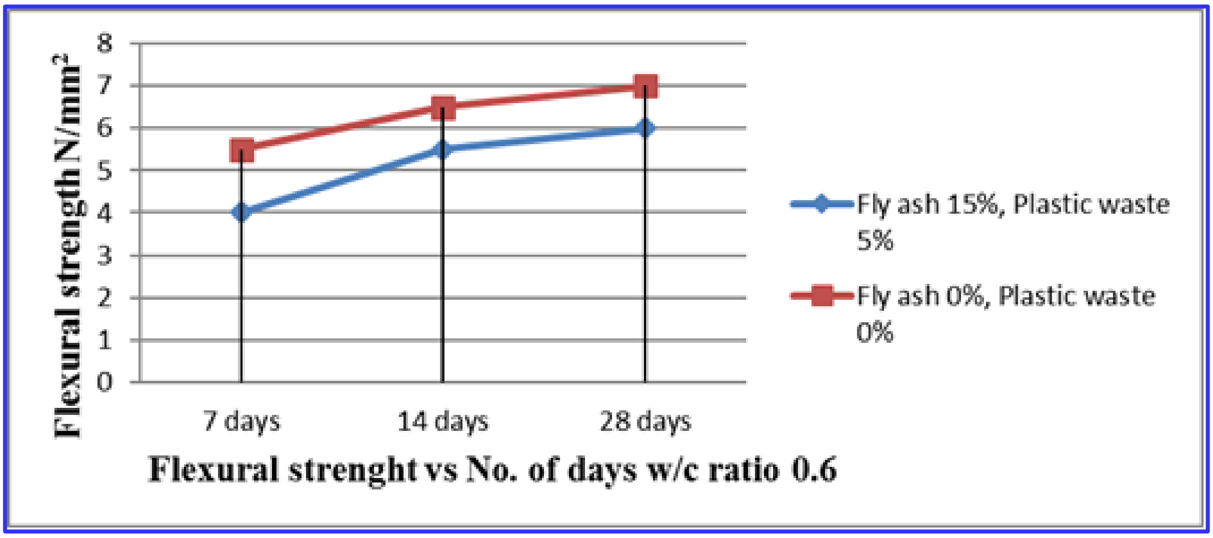


Table 6. Flexural strength of concrete at water-cement ratio 0.6

S.N.	Beam designation	Flexural strength(N/mm^2)			% age of Fly ash	% age of Plastic Waste	W/C Ratio
		7 days	14 days	28 days			
1	B1	5.5	6.5	7.0	0	0	0.60
2	B2	4.0	5.5	6.0	15	5	0.60



Flexural strength of concrete varies from 7.5MPa to 7MPa 28 days for the water-cement ratio of 0.55 and 7MPa to 6MPa at 28 days for the water-cement ratio of 0.6. Once again, similar behavior was found in flexural testing like compressive strength and split tensile strength, incorporation of fly ash, plastic waste.

4. CONCLUSION

According to the experimental study and result after discussions, there are concluded by partially replaced cement and coarse aggregate with fly ash and plastic waste with different water-cement ratios, the strength of concrete specimens was observed almost the same in compression tension and flexural. In 0.55 water-cement ratio, strength enhancement is the same in all ages but more than the strength gain of 0.6 water-cement ratios. Based on results, for paver concrete blocks, fly ash and the plastic waste combination can effectively be used in concrete. Also, maximum consumption of these waste materials in concrete is the best possible way to reduce health safety issues and environmental pollution, and water pollution due to their harmful effect.

Future recommendation

The potential applications of fly ash and plastic waste-based concrete can be investigated as per the requirement of the market. Their advantages in concrete can further be examined in the laboratory as building materials. Maximum utilization of these materials in concrete as a building material is the best way to reduce environmental pollution problems, dust problems, water pollution problems, and open land encroachment problems. These research outcomes are leading towards the use of fly ash and plastic waste in concrete as pavement blocks. Plastic waste and fly ash depositing in surrounded water bodies are becoming big problems for living creatures. For the safety of health, life cycle, and environment, monitoring and maximum utilization of these materials are required.

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